Lean Construction: A New Approach to Managing Projects
Gregory A. Howell, P.E.

Abstract

Lean Construction, a new approach to managing projects has demonstrated remarkable results. Project safety, quality, cost and schedule performance are all improved on projects managed under Lean protocols. Unlike current forms of project management, Lean Construction is a production management based system that aims to increase value and reduce waste by first making workflow between specialists more predictable. The foundations and fundamentals of this new approach, its perspective and how it conforms to Lean principles will be presented.

Introduction

Projects take too long, cost too much, kill too many. And projects fail to deliver performance expected by clients or profit expected by designers, contractors and suppliers. These failures are usually attributed to poor choices made by one or another of the participating organizations or unexpected circumstance. Experience applying Lean principles to the management of projects reveals deeper problems in the structure and practices of project management. Lean construction comes to grips with these issues.

Some results and the extent of application worldwide support the claim that this new approach works and is worth considering. Projects managed "Lean[1]" show a variety of improved outcomes. Some report reduced durations of up to 30% while costs are reduced in the same range. In Denmark, companies report that profit has increased by 30% and safety with 50% Punch lists are reduced and project outcomes are more predictable. Firefighting in general and accidents in particular are reduced. The impact of change is reduced because decisions can be taken later without requiring work to be redone. Lean based project management is now being applied by the largest contractors in Brazil, Chile, Denmark (Larsen et al 2003), Peru, Spain and the United Kingdom and some of the larges projects[2]. Similar results have been achieved in the United States on a wide variety of projects. As impressive as they may be, claim of success alone rarely persuade and in themselves do not explain either the driving force behind the success or the differences between Lean and current practice. So what makes Lean work? This paper proceeds by first discussing the foundations of the lean perspective and then considers two specific foundations that explain both why Lean Construction works better than current practice. The paper closes with a brief comparison of Lean and current practice.

The Foundations of Lean Construction

Lean foundations can be grouped into three broad headings

1. **Complexity and Uncertainty**

   The future is uncertain and unknowable. While we can shape it by our actions, we can't see into the future. Project participants are linked in complex interdependent webs of activities and commitments. At the edge, complex, uncertain and short

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[1] "Lean" is a term applied to a new form of production management that is neither "craft" nor "mass". It does not refer to reducing overhead or staff, and should not be used in construction with "mean". Think of it as new production theory. See Womack and Jones 1990 for a history of its development in manufacturing.

[2] See also the International Group for Lean Construction. The papers presented at the 11th Annual IGLC Meeting can be found at http://www.strobos.ce.vt.edu/iglc11/index.html.

projects can slide into chaos. Worse, even simple projects can spiral out of control when the project management organization is unable cope with external and internal sources of stress. In this circumstance, classic controls may do more harm than good.

Lean is an approach that aims for simplicity and certainty where possible but recognizes order is a local and fleeting state. Planning in Lean shapes the future and organizes necessary work. It does not attempt to create a detailed model of that future and enforce its creation.

2. **Theory of projects and production**

   Projects are more than a collection of sequentially related activities. Managing production, the way work is done in project settings must fully consider the management of activities, the flow of work within and between those activities and the generation and delivery of value. Production, the work in projects, cannot be managed by commercial contracts.

   Lean Construction management is a production management based approach to the design, management and improvement of project based production systems. Improving the predictability of workflow is a first concern in production systems and creating the organization to sustain it is the focus of management. Point speed and productivity are less important than system throughput. Improving workflow predictability improves throughput. Waste is reduced when "physical" work is managed Lean.

3. **The central role of people and language**

   People deliver projects; they live and work in networks of commitments. Making and keeping commitments, specific promises for particular results, happens in language. Doing what you say is at the heart of creating trust, assuring reliable workflow and delivering value. Lean project management designs and activates the network of commitments between people.

Project management is always about getting work done. Lean is successful because people working on projects can create predictable workflow, even in complex and uncertain circumstances by making and keeping promises. (Some caution is appropriate here. Lean extends far beyond reliable workflow and promising, but this is the place to start if we are to understand the difference between Lean and current practice, and to begin implementation. For a fuller explanation see Ballard & Howell (2003))

Why reliable work flow?

Time and cost are always in tension so managers must cope with the dread "Time/Cost Tradeoff". Normally this trade is understood as the result of increasing speed of an activity and this isn't totally wrong. But a more careful exploration of the underlying physics reveals a new possibility – time and cost will still need to be traded but at higher levels of performance. More frequently the need to trade time and cost is eliminated by increasing the reliability of workflow.

We all know it takes longer to get home at rush hour, and it can take a lot longer if just a few erratic drivers cause cascading brake lights. As traffic moves from light to heavy, delays increase and they increase rapidly when variation is introduced to the flow. This relationship is explained in queuing theory as applied to production management. (Hopp & Spearman 2000). The time for each car to get home increases as the utilization of the highway increases. The increase in travel time is rapid as 100% utilization of the highway's capacity is approached. This effect is always present in production systems with 2 components such as work and workers. As

the productivity (capacity utilization) of the workers increases, delivery time is extended – the time cost/tradeoff.

While we may want some systems to run at high capacity utilization or productivity, in some cases we prefer low utilization because it gives us rapid response. For example, we do not want our emergency services to be running at full capacity when our house catches on fire. Wait time always increases as capacity utilization increases – we all know that. And we know the second rule, "Delay increases more rapidly as variation increases."

In the highway metaphor, a few crazy drivers can bring the system to a halt at rush hour even if they don't hit some one. And if they do, it takes a long time to clean up the mess. By contrast, the same crazy driver has little impact on transit time at 3AM. At least the paramedics can get there quickly if he does hit you. The impact of variation on travel time increases as the system approaches full utilization. Metering on ramps at rush hour reduces variation on the highway thus effectively increasing the available capacity and reducing travel time. For a given number of cars on the highway, you will be late for dinner in relation to the variation in flow. The same effect applies on projects.

Consider a project at point "A" in the Figure 1. The owner might want to shorten the delivery but this will require reducing capacity utilization, most frequently by adding people so workers will always be available (standing and waiting) for work from upstream. By contrast, the contractor wants to make more money by increasing labor utilization. This means having work standing idle waiting for workers.

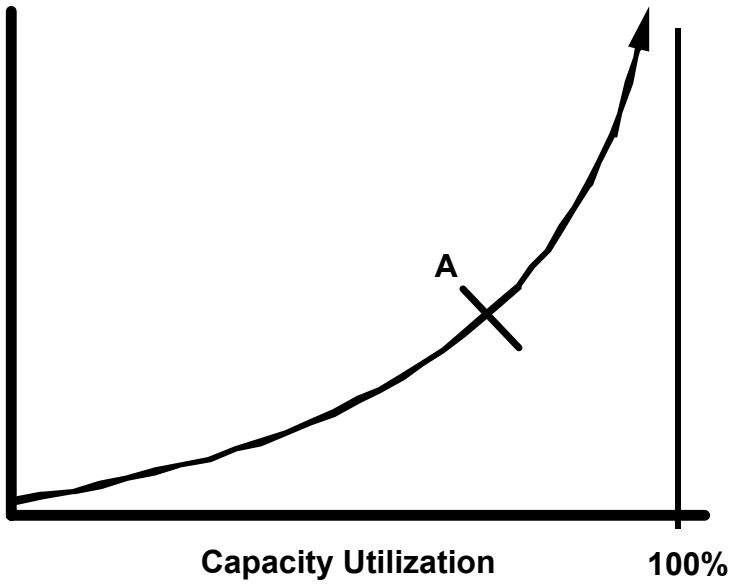

Figure 1. Capacity/Delay Curve

Project management as applied today recognizes the relationship between capacity utilization and delivery time but fails to recognize that the shape of the curve, the rate at which delays increase with utilization is a function of the variation in release of work from one crew to the next. Lacking appreciation for the physics of production, managers push each task to go as fast as possible with the predictable result of reduced workflow predictability. Costs increase along with

duration as workflow reliability degenerates. Matters are made worse when cost and schedule controls cause the variation in work flow to increase. This happens when managers push people to work at higher productivity or to complete their work in a sequence that does not release work to the next crew in a predictable flow and the right sequence,

In Lean we first work to improve workflow predictability by assuring only reliable assignments are released into the flow of work by the planning system. (See papers posted at http://www.leanconstruction.org under "Production Control" for a full explanation of the Last Planner System™.) Workflow reliability improves with increased planning reliability. Percent Plan Complete (PPC) is calculated by dividing the number of tasks completed to hand off criteria by the total assigned to the crew. This is not a productivity measure because no partial credit is given. For example, if a crew or design squad completes 6 of ten tasks assigned, PPC would be 60% even if they completed 6 activities and 80% of the remaining four. Figure 2 below shows how improving planning system performance changes the shape of the capacity/delay curve allowing both time and cost to be saved. Delays still mount up as utilization increases but the increase occurs at higher levels of performance for both factors. Improving workflow reliability has another affect on project performance. Project outcomes become more predictable as reliability increases. A lot of cars on the road will always increase travel time. A few crazy drivers make travel time longer and dinner even more unpredictable.

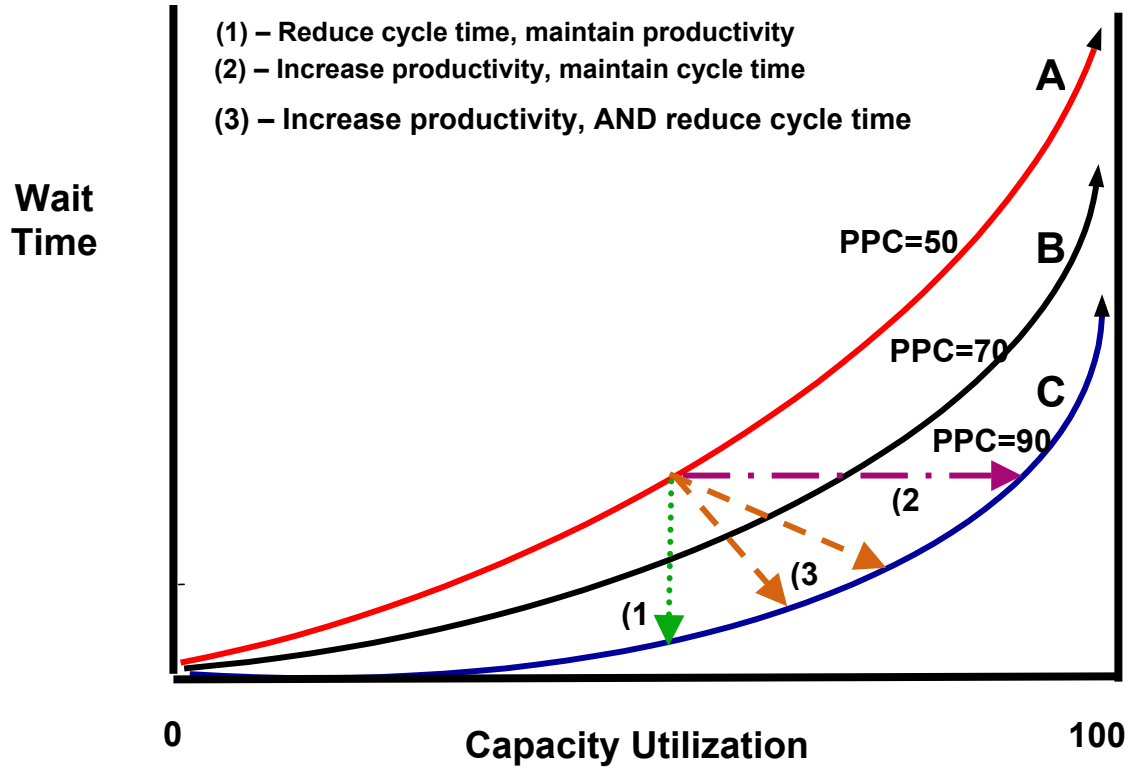

Figure 2: Capacity Utilization and Planning Performance

Why do we need reliable workflow? Because it is a key first step to improve project performance.

How do we get reliable workflow?

People make workflow reliable by how they manage planning. Planning is always conversation, even if you are only talking to yourself. The planning system shapes those conversations and establishes the network of commitments needed to make work happen. In Lean Construction, planning prepares the team to be in action together and concludes with promising.

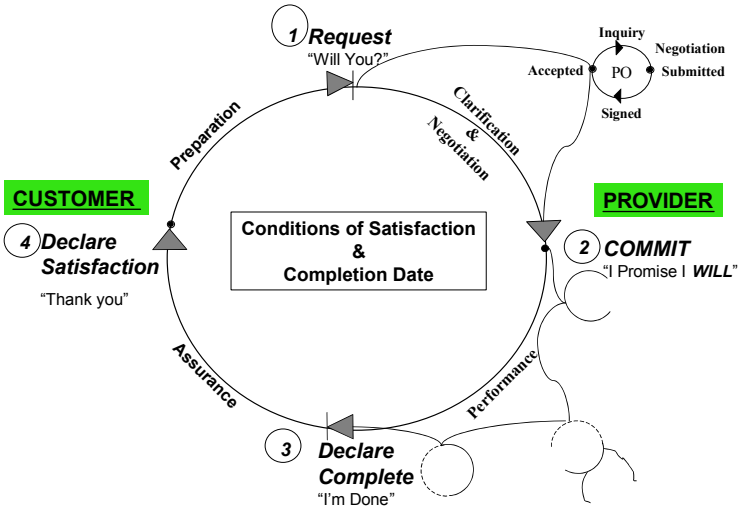

Figure 3. The Commitment Cycle

Linguistic action (Macomber & Howell 2003) theory offers a simple observable description of the commitment process; it explains how promises are made. Projects are always promises – big risky promises by a provider to a customer. While promises at highest level may form the basis for commercial contracts they do not assure success or that people can do the work that they should. Projects are completed by a unique set of people acting in unique network of commitments.

Fernando Flores goes further, claiming that the work of organizations is making and keeping commitments (Flores 1982). Making and keeping commitments, while a different kind of work than the "horse power" work, connects through the planning system directly to the management of physical work, the creation of reliable workflow, the creation and delivery of value and the establishment of trust.

Projects are becoming more complex, the are carried out under conditions of greater uncertainty and are ever more pressed for speed. In a sense, we are trying to drive very close together at very high speeds on dark and rainy nights. Giving each car (activity) its own siren and ever urging the driver faster only compounds the problem.

Lean Project Management

The most general objectives of Lean Project Management are to increase value and reduce waste. At first blush, these appear to be the same objectives driving the current approach. But current practice tries to achieve these objectives by increasing performance of each activity. This approach overlooks the importance of reliability in reducing waste at the project level, and the importance of making and keeping of commitments at the working level to the delivery of value. Enough of the conceptual approach, here is a comparison of Lean and current practice.

	Current Practice	Lean
Planning	**Knowing**	**Learning & Promising**
Uncertainty	**External**	**Internal**
Control	**Tracking**	**Steering**
Coordination	**Following Orders**	**Keeping a promise**
The Goal of Supervision	**Point Speed & Productivity**	**Reduce Variation & Manage Flow**
Commercial Contracts	**Trade Production System Efficiency for Apparent Security**	**Aligns Production System Objectives with Interests**

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